PRINCETON UNIVERSITY OBSERVATORY

Princeton, N. J.

PROGRESS REPORT

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Subject: Balloon Project

Principal Investigator: Dr. Martin Schwarzschild

Executive Director: Dr. Robert E. Danielson

Period Covered: May 1964 - October 1964

1. Evaluation Flight No. 6.

This flight was carried out with two major aims: First, to test the Stratoscope II Balloon System with regard to its ability to carry a substantially heavier payload than previously, and second, to test Vitro's new instrumentation for side arm orientation on landing. The first aim was important because the weight of Stratoscope II had steadily increased by the addition of necessary auxiliary equipment and had reached a value so that the balloon ballast that could be carried without increasing the total weight had become uncomfortably low (careful engineering investigations by Vitro had previously shown that the present Stratoscope Balloon System could carry a weight noticeably higher than that carried in previous flights without reducing the safety factors to dangerous values). The second aim on the other hand was directed towards further reducing the probable damage to the telescope on landing.

This evaluation flight was carried out on June 2. The launching operations went smoothly until in the last moment an electrical failure occurred. It turned out that this failure could be corrected but caused a delay of the launch from just before sunset until just before sunrise. This unscheduled delay necessitated reducing the overall weight of the dummyload somewhat because of the night cooling of the helium. In spite of this reduction from the original aim the balloon system carried through the critical ascent phases of maximum balloon systems stress a load of approximately 900 lbs. in excess of all previous loads, an entirely satisfactory increase.

The balloon operations during ascent, during float, and during the main portion of the descent occurred entirely according to plan. When on descent the instrument came into close sight of the tracking aircraft the new side arm orientation instrument was turned on and functioned exactly as programmed. To save batteries the orientation system was then turned off for awhile and turned on again only after the balloon had descended below an unstable cumulus layer at 5,000 ft. The convective air motions below this layer made the balloon carry out its final descent somewhat faster than planned, -too fast for the orientation device to execute its mission. This last event clearly suggests a somewhat different timing of the operation of the new device while at the same time the first test carried through during the earlier phase in the descent proved out the device in its technical functioning.

In consequence of the experiences of this evaluation flight it was decided first, that a substantially increased total load could be carried by the present Stratoscope II balloon system and second, that the side arm orientation device should be applied to the next scientific Stratoscope II flight.

2. Cosmic Ray Background.

During the second scientific flight it had been noted that the photomultiplier tubes used in the pointing mechanism of Stratoscope II showed a background noise higher than expected for the temperatures reached by the photomultipliers at float. The suspicion arose that this background might be caused by cosmic rays. Accordingly, a special small test flight was carried out on July 20th in which one of the regular photomultiplier assemblies, equipped with the necessary power supply and a simple recorder, was sent to 60,000 ft. The record obtained clearly showed an increasing background noise during ascent and a corresponding decrease in the background during descent on parachute.

It seemed plausible after this experiment that the observed background increase might be caused by scintillations excited by cosmic rays in the cone condenser, a heavy glass block just in front of the photomultiplier. Accordingly, another small test flight was carried out, identical to the first, however with a black paper separating the cone condenser from the photomultiplier. No significant difference was found in the record from this second flight compared to that of the first one. It seemed necessary to conclude that the cosmic ray disturbances occurred in the photomultiplier itself rather than in the cone condenser. One more attempt was made to reduce this increased background by still another test flight in which an electronic clipper circuit was added to the previous instrumentation for the purpose of eliminating the cosmic ray pulses under the assumption that they were likely much larger than the standard pulses. Once again no noticeable changes from the results of the preceding tests were found in the new record.

Clearly, the problem of this excess background in the photomultipliers has not been solved by these tests up to date. Many balloon and rocket experimentalists were consulted on this point but as far as could be established, no other present experiment is using photomultipliers in flight experiments at the very high sensitivity levels to which they are pushed in this Stratoscope project, so that for all other experiments this excess background is either quite undetectable or at least sufficiently small not to be bothersome. Further test flights in this connection are being planned.

The three test flights this far carried out were handled by the balloon crew of the NCAR Scientific Balloon Flight Station and surplus balloons were used for them.

3. Preparation of Stratoscope II for its First Photographic Flight.

At the Perkin-Elmer Plant in Norwalk, Connecticut the cooling tests for the primary mirror were satisfactorily completed. At the same time the final phases of the conversion of Stratoscope II from its infrared configuration to its photographic configuration were accomplished and the in-flight alignment equipment (see previous report) was designed and constructed.

On June 22, the instrument, completely disassembled, was shipped to the balloon flight station at Palestine, Texas. Simultaneously, the entire Perkin-Elmer Stratoscope group as well as part of the Princeton Stratoscope group moved there. During the following ten weeks the instrument was completely assembled. This included cold testing of many subassemblies (because of possible strains experienced during transportation) as well as the connecting of the coarse and the fine servo loops for the first time. Just before vacation (August 22 to September 8) the instrument succeeded in tracking stars with the two stage pointing mechanism in a satisfactory manner even though some disturbing resonances had still to be overcome. The latter was achieved after vacation during September.

After the July cosmic ray test flight with its disturbing result it appeared highly desirable if it were possible, at least for the brighter objects, to get along with only one guide star, the principal guide star, and to be able to eliminate the second guide star needed to orient the telescope in rotation around its optical axis. Since it turned out easy to select for the majority of the astronomical objects to be photographed one guide star amply bright enough not to be disturbed by the excess background noise for the photomultipliers, while for several of these objects the second selected guide star was dangerously faint in comparison with the excess background. Accordingly, it was decided late in July to add to Stratoscope II a gyro as the sensor of rotation around the optical axis of the telescope (the precision required around this axis is only about one hundredth that required by the other two coordinates so that the best available gyros turned out just sufficient for this specific purpose though they would not be accurate enough by a full factor of one hundred

for the primary pointing of the telescope). The Perkin-Elmer engineers succeeded in selecting, procuring and installing with all its auxiliary equipment such a gyro by about the middle of October.

In spite of the generally very satisfactory progress of the preparations, enough of the final testing and practicing was still to be done by the end of this report period that the flight readiness date, originally scheduled for November 17, was postponed by one week to November 24.

4. Integrating television.

During this report period the RCA group, under contract with Princeton for building a flying integrating television camera, made a good start on building this camera and simultaneously succeeded by further testing and improving the operation of such a camera so that even slightly higher gains relative to a photographic camera may be expected than those originally indicated. This work has been described in an article published in Applied Optics, Vol. 3, No. 6, June 1964.

5. Scientific Analysis.

The analysis of all of the observational data from the second infrared flight of Stratoscope II has been completed and two papers, one on the red giants and one on the absorption by interstellar ice grains, have been submitted to the Astrophysical Journal, where they have appeared in the meantime. Two further articles, one on the infrared spectrum of the moon and one on Jupiter could not quite be completed prior to the moving date from Princeton to Palestine.